

An Optimality-Theoretic Account of Diachronic Consonant Cluster Simplification in English*

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This paper deals with the issue of representing historical sound change within the framework of Optimality Theory. It is generally accepted in Optimality Theory that both language change and synchronic variations are characterized by employing simultaneous constraint reranking. In this paper, however, I argue that historical sound change, in sharp contrast with variations, must be decomposed into a series of unranking (softening), reranking, and ranking (hardening) process in order to accommodate the gradual aspect of historical sound change. Based on the new interpretation of the dotted line, I also argue that constraint reranking should be applied not across the solid line but across the dotted line in the domain of sound change.

Key words: historical sound change, optimality theory, constraint reranking, consonant cluster simplification, frequency, domination

1. Introduction

All living languages change gradually with time. Diachronic changes can be witnessed in all components of grammar, including phonology. As such, sound changes are inevitable and a more restrictive accounting of them has to be included in any phonological theory. In a rule-based theory, sound change is accounted for by means of rule addition, rule

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insertion, rule loss, rule reordering, and rule simplification (Halle, 1962; Kiparsky, 1968; King, 1969). On the other hand, in Optimality Theory (OT, McCarthy & Prince, 1993; Prince & Smolensky, 1993), another method has been sought in explaining sound change because OT, a constraint-based theory, does not employ the process of rule operation.

OT claims that "individual grammars are constructed by imposing a ranking on the universal constraint set ... Interlinguistic variation is to be explained primarily as the result of differences in the ranking of constraints" (McCarthy & Prince, 1993, p. 5). Just as cross-linguistic variation is accounted for by means of the reranking of constraints, we have good reason to believe that diachronic sound changes are also due to different constraint rankings. Thus, constraint reranking is invoked in OT to account for the sound change (Jacobs, 1995; Bermúdez-Otero, 1996; Cho, 1998; Green, 2001).

Even in the optimality-theoretic approaches, however, historical sound change was categorically, not gradiently, represented by appealing only to constraint reranking. In this paper, I propose that historical sound change can be naturally represented as a series of unranking, reranking, and ranking strategy within the optimality-theoretic framework.¹⁾ For this, I divide the whole procedure of historical development into four stages. This is to represent the gradient nature of historical sound change. I also reinterpret the constraint reranking system and the implication of dotted line in the OT. The data examined here are consonant cluster simplification (CC simplification) from Middle English (ME) to Modern English (ModE) with a focus on the word initial change from [kn] to [n].

This paper is organized as follows. Section 2 critically reviews two previous studies on sound change in OT: Cho (1998) and Green (2001). In section 3.1, a brief mention is made on the cause and the scenario of sound change. In section 3.2, based on the word initial [kn] to [n] simplification, I propose a new optimality-theoretic analysis of sound change. By means of a series of unranking, reranking, and ranking strategy, the gradual characterization of historical sound change is naturally represented within my approach. I also reinterpret the

1) One of the reviewers raised a fundamental question of an apparent incompatibility between the main tenet of Generative Grammar and the formalization of historical sound change proposed in this paper. Even though the question is critically relevant to our discussion of sound change, any definite answer seems to be beyond the scope of this paper.

implication of the dotted line in order to show the shift of frequency in the diachronic variation. Section 3.3 deals with advantages of my analysis over the previous approaches. Section 4 concludes this paper with theoretical implications of the new proposal.

2. Previous Studies

2.1. Cho (1998) : A Free-variationist Account

As an optimality-theoretic account, Cho (1998) proposes an analysis of language change as reranking of constraints. Assuming that the reranking between Constraint 1 (Const1) and Constraint 2 (Const2) has to be mediated by two stages of undoing the ranking and creating the new ranking, she characterizes the permissible and impermissible constraint reranking as in (1).

(1) Reranking of constraints

- a. Permissible: Const1 » Const2 → Const1, Const2 → Const2 » Const1
- b. Impermissible: Const1 » Const2 → Const2 » Const1 in one step.

A typical example is the $n \sim \emptyset$ alternation in Korean historical phonology. She states, "in the late 18th century the coronal nasal n started to delete in word-initial position before the high front vowel /i/ and the glide /y/. As a result, /ni/ has been completely neutralized in the initial position in the Modern Standard Korean" (Cho, 1998, pp. 53-54). To be concrete, she explains the replacement of earlier /nip/ 'leaf' with the new form /ip/ by employing constraint reranking between Faithfulness and the *[ni constraint. The relevant constraints can be defined as follows:

(2) Faithfulness

The output is faithful to the input.

(3) *[ni


/ni/ is ill-formed in the initial position of a phonological word.

Before the 17th century, Faithfulness dominated *[ni and only /nip/ form was used. After the unranking stage in the 18th century when both /nip/ and /ip/ forms occurred side by side, *[ni was finally ranked



above Faithfulness in the 19th century and only /ip/ form was used in Modern Standard Korean. The historical development is presented in (4).

(4) $n \sim \emptyset$ alternation in Korean


a. before the 17th century

/nip/ 'leaf'	Faithfulness	*[ni
 nip		*
ip	* !	

b. the 18th century

/nip/ 'leaf'	Faithfulness	*[ni
 nip		*
 ip	*	

c. after the 19th century

/nip/ 'leaf'	*[ni	Faithfulness
nip	* !	
 ip		*

Cho postulates an *unranking* stage (4b) in order to accommodate variation and adopts a free-variationist model, which is sketched by Bermúdez-Otero (1996, p. 5) as in (5).

(5) Free-variationist model of sound change

Stage 1 (no variation)

$C_1 \gg C_2$

↓

Stage 2 (free variation)

C_1, C_2

↓

Stage 3 (no variation)

$C_2 \gg C_1$

According to the free-variationist model (5), it is implied that, at the intermediate stage, both variants (/nip/ and /ip/) are “equally harmonic and thus simultaneously available to each speaker of the language at all times” (Green, 2001, p. 11). As Green points out, however, this is unlikely from the sociolinguistic viewpoint, because the variants are not likely to surface simultaneously with the same frequency. Furthermore, though it

may be right to introduce an unranking stage for modelling variation, I think the unranking process needs to be subdivided in order to capture the gradual nature of the historical sound change.

2.2. Green (2001) : A Free Ranking Account

Green (2001) also argues that constraint reranking is responsible for a large amount of diachronic variation. Besides, in response to the question “How do constraint rankings change?”, he proposes ‘the Promotion of the Unmarked’ as an extension of the theory of the Emergence of the Unmarked (McCarthy & Prince, 1994). The Promotion of the Unmarked means that a constraint against a marked pattern is promoted upwards in the constraint hierarchy. In other words, “the sound change is the result of the promotion of a constraint against a marked phonological pattern” (Green, 2001, p. 1).

As a piece of evidence for the Promotion of the Unmarked, he offers the simplification of the initial *kn*- clusters to *n*- occurring between ME and ModE. In ME, the *kn*- cluster was permitted as an onset while it was not in ModE: *kn*- was simplified into *n*-. Put in OT terms, he states in ME the Faithfulness constraints outranked the *₀[kn constraint which prohibits the sequence in syllable-initial position. But at some point, speakers promoted the phonological constraint *₀[kn, recognizing that *kn*- was an unacceptable onset cluster. Once *₀[kn was promoted, one of the faithfulness constraints, MAX, was demoted in order for a candidate to be judged optimal (Green, 2001, p. 8). The tableau representing this historical development is given in (6).²

(6) a. Middle English

/knou/	DEP	MAX	IDENT(nasal)	I-CONTIG	* ₀ [kn
kənou	* !				
nou		* !			
krou			* !		
kou		* !		*	
☞ knou					*

2) I-CONTIG (“No Skipping”) (McCarthy and Prince, 1995, p. 371)
The portion of S_i standing in correspondence forms a contiguous string.
Domain (R) is a single contiguous string in S_i.

b. Modern English

/knou/	DEP	IDENT(nasal)	I-CONTIG	* _o [kn	MAX
kənou	* !				
knou					*
krou		* !			
kou			* !		*
knou				* !	

(Green, 2001, p. 8)

Concerning the intermediate stage showing the variation, Green postulates, for sociolinguistic reasons, *free ranking* of adjacent constraints instead of *unranking*.³⁾ From a sociolinguistic viewpoint, he argues, “it is far more plausible that at the time when *knou* and *nou* were found side by side, there were geographic, stylistic, and/or generational implications to each form” (Green, 2001, p. 11). That is, it is unlikely that the variants surface simultaneously with the same frequency. So he presents the free ranking model of sound change as in (7).

- (7) Free ranking and reranking of MAX and *_o[kn
 - a. Middle English : MAX >> *_o[kn
 - b. Intermediate stage
 - Grammar A : MAX >> *_o[kn
 - Grammar B : *_o[kn >> MAX
 - c. Early Modern English: *_o[kn >> MAX

(Green, 2001, p. 12)

Under the free ranking system, we need two separate tableaux representing each grammar at the intermediate stage. In the case of more than two variants, however, this free ranking approach can impose a heavy burden on grammar because it is forced to generate all the relevant grammars depending on external, sociolinguistic factors. Furthermore, the shift of the frequency in variants cannot be properly captured in the free ranking model. The free ranking model merely shows that one of the variants was used in some particular context, the

3) According to Clements (1997, p. 315), *free ranking* is defined as follows:
“When two constraint C₁ and C₂ are freely ranked, two tableaux are constructed for each input, in one of which C₁ > C₂ and in the other of which C₂ > C₁. The winning candidates in each tableau are retained as alternative output forms.”

choice of which depends on the various sociolinguistic factors. It does not present the natural flow of frequency in variants throughout ME to ModE. Even if the flow of frequency in variants can be accommodated in this model, by stipulating the preponderance of Grammar B over Grammar A, the possibility of the reverse shift of frequency in variants cannot be ruled out.

To sum up, although Cho (1998) and Green (2001), respectively, introduce unranking process and free ranking in order to explain the variation, they both could not show the gradual nature of historical sound change properly, especially the shift of frequency in variants. Thus, I will divide the whole procedure of historical development into four stages to represent the gradient nature of historical sound change, integrating the merits while overcoming the demerits of both approaches. In section 3, I will propose that historical sound change can be naturally represented as a series of unranking, reranking, and ranking strategy within the optimality-theoretic framework. In addition, I will reinterpret the constraint reranking system and the meaning of the dotted line in OT.

3. Reranking in Sound Change

3.1. The Cause and the Scenario of Sound Change

Before taking up the main subject, I will briefly discuss ‘the cause of sound change’ and ‘the scenario of sound change’. Firstly, why does sound change occur? It can be said that language is in a state of constant tension between two driving forces: the easiness of the speaker’s articulation and the clarity of the listener’s perception. Language is always affected, controlled, and balanced by these two forces. The conflict between these two forces is also reflected in the sound change.

In the case of CC simplification, cluster simplification itself is the result of facilitating the speaker’s articulation because it is much easier to pronounce one segment rather than two. At the same time, in deciding which segment is deleted, listener’s position is taken into account because the segment with the larger perceptual salience can be better heard. As such, a tendency toward simplification is counteracted by the need to increase clarity, and much of the language change is the result of a balance between the two forces.

In terms of OT, we can find that the markedness constraint *COMPLEX and the faithfulness constraint MAX-IO play an important role in explaining CC simplification. Furthermore, MAX-IO constraint must be divided into MAX (More-Sal C) and MAX (Less-Sal C) in order to correctly select which segment is deleted in the cluster. The relevant constraints are shown in (8).⁴⁾

- (8) a. *COMPLEX: Syllables have at most one consonant at an edge.
- b. MAX (More-Sal C)
 The input's more salient consonant has a correspondent in the output.
- c. MAX (Less-Sal C)
 The input's less salient consonant has a correspondent in the output.

As to the scenario of sound change, we have to make two assumptions. First, "one of the basic ideas that a theory of language change must encode is that the change is *gradual*" (Bermúdez-Otero, 1996, p. 4). Second, "language change is unthinkable without structural *variation*" (Harnad, 1999, p. 8). Based on these assumptions, we can suggest the scenario of language change as found in (9).

- (9) Scenario of language change
 - a. In an earlier time, there was only linguistic structure A.
 - b. In an intermediate time, there was some structural variation: A and B.
 - i) B began to appear and spread at some point, but A was still prevalently used.
 - ii) B became more and more frequently used than A.
 - c. In a later time, the high-frequent structure B became obligatory, and the low-frequent item A was lost altogether.

This scenario properly shows the gradual nature of sound change.⁵⁾ In the

4) I adopt the Salience Hierarchy in Lee (1996, p. 167).

- Definition : Physiologically and acoustically, the more complex segments are more salient.
- Example : Nasal > Oral
- Labial, Velar > Coronal

next section, with the example *know*, I will propose a new approach of representing historical sound change in OT.

3.2. Diachronic Reranking Hypothesis

According to the scenario of sound change (9), we can describe a historical development procedure of *know* as shown in (10).

- (10) CC simplification from ME to ModE
- a. In ME, *know* was pronounced [knou].
 - b. In the intermediate stages between ME and ModE,
 - i) [nou] began to appear and spread, but [knou] was still prevalently used.
 - ii) [nou] became more and more frequently used than [knou].
 - c. In ModE, [knou] was finally simplified to [nou].

How can we represent this gradual aspect of historical CC simplification in OT tableau? How can we express the shift of frequency in variation with the categorically-oriented tableau?

First, I argue that the historical sound change must be represented as a series of unranking, reranking, and ranking processes. Contrary to the previous optimality-theoretic approaches, constraint reranking should be applied, not across the solid line, but across the vertical dotted line in the case of sound change. This Diachronic Reranking Hypothesis is suggested in (11).

(11) Diachronic Reranking Hypothesis

Historical sound change must be represented as a series of unranking, reranking, and ranking processes. Furthermore, in the domain of sound change, there is no constraint reranking strategy which directly passes across the solid line.

Second, I introduce a new concept to reflect the shift of frequency in variation in OT. I argue that the dotted line should be newly interpreted

5) This scenario of sound change is similar in nature to Haspelmath's (1999) idea. Ohala (1993) also implies this kind of the sound change scenario. The validation of this scenario, however, will require further empirical observation.

into two types and a different meaning be given depending on each type.

In OT, "solid lines between constraints indicate crucial rankings while dotted lines indicate that the ranking is not (or not yet) crucial" (Archangeli, 1997, p. 12). However, in fact, the dotted line is often used in two conceptually distinct cases: crucial and noncrucial nonranking.⁶⁾ Whereas noncrucial nonranking indicates the situation in which constraints cannot be ranked with respect to each other due to a lack of interaction, crucial nonranking is concerned with variation in which neither constraint can dominate the other. Thus, I propose the dotted line be divided into two types. One is a vertical dotted line, which is concerned with variation. The other is a horizontal dotted line indicating the case where constraints cannot be ranked, with respect to each other, due to a lack of interaction. This division fits in with the original conventions of constraint tableau in OT: "left-to-right column order mirrors the domination order of the constraints" (McCarthy & Prince, 1993, p. 6).

Then, what is the implication of the vertical dotted line in OT tableau? I suggest that it does imply the difference of the frequency in variation. The more left the constraint is positioned in the crucial nonranking, the more strongly it affects frequency of the variation.

Based on the assumptions above, I will introduce new terms and notations in the constraint tableau of the OT. Their definitions and schematized tableaux are as in (12).

(12) New terms and notations

a. Hard domination

- i) Definition: domination in which two conflicting constraints C_1 and C_2 are ranked in either of the two ways: $C_1 \gg C_2$ or $C_2 \gg C_1$. Two constraints are strictly ranked. This domination is indicated by the solid line.

6) The term *crucial nonranking* is first mentioned in Prince and Smolensky (1993, p. 51): "... we assume that the basic ranking hypothesis is that there is some total ranking which works; there could be (and typically will be) several, because a total ranking will often impose noncrucial domination relations (noncrucial in that either order will work). It is entirely conceivable that the grammar should recognize nonranking of pairs of constraints, but this opens up the possibility of crucial nonranking (neither can dominate the other; both rankings are allowed), for which we have not yet found evidence. Given present understanding, we accept the hypothesis that there is a total order of domination on the constraint set; that is, that all nonrankings are noncrucial."

ii) A tableau for hard domination: $C_1 \succ C_2$, C and A surfaces as optimal.

	C_1	C_2
$\# \# \#$ <i>Cand A</i>		
<i>Cand B</i>		*

b. Soft domination

i) Definition: domination in which two conflicting constraints C_1 and C_2 are ranked in either of the two ways: $C_1 \succ C_2$ or $C_2 \succ C_1$. Two constraints are not strictly ranked, but they affect the frequency of occurrence in the output form. This domination is indicated by the vertical dotted line.

ii) A tableau for soft domination: $C_1 \succ C_2$,
Cand A surfaces more frequently than *C* and *B*.

	C_1	C_2
$\#$ <i>Cand A</i>		*
$\#$ <i>Cand B</i>	*	

c. Non domination

i) Definition: domination in which two constraints C_1 and C_2 are equally ranked in either of the two ways: C_1, C_2 or C_2, C_1 . Two constraints cannot be ranked with respect to each other due to a lack of interaction. This domination is indicated by the horizontal dotted line.

ii) A tableau for non domination: C_1, C_2 .
The optimal surface form cannot be determined as it is.

	C_1
	C_2
<i>Cand A</i>	*
<i>Cand B</i>	*

d. $\#$: the more frequent output form

$\#$: the less frequent output form

$\# \# \#$: the optimal output form


Along with (12), Diachronic Reranking Hypothesis of (11) can be redefined in a concise way like (13).

(13) Diachronic Reranking Hypothesis

Diachronic reranking occurs only when constraints are in a 'soft' domination situation.



Let us now represent the gradual aspect of CC simplification from ME to ModE in a newly suggested constraint tableau of OT. As I mentioned before, historical sound change must be represented as a series of unranking, reranking, and ranking processes. The whole procedure of CC simplification from ME to ModE is as found in (14).

(14) a. Middle English

/knou/	MAX(More-Sal-C)	MAX(Less-Sal-C)	*COMPLEX
nou		* !	
kou	* !		
 knou			*



↓ (unranking or softening)

b. Intermediate Stage 1

/knou/	MAX(More-Sal-C)	MAX(Less-Sal-C)	*COMPLEX
 nou		*	
kou	* !		
 knou			*


↓ (reranking)

c. Intermediate Stage 2

/knou/	MAX(More-Sal-C)	*COMPLEX	MAX(Less-Sal-C)
 nou			*
kou	* !		
 knou		*	

↓ (ranking or hardening)

d. Modern English

/knou/	MAX(More-Sal-C)	*COMPLEX	MAX(Less-Sal-C)
 nou			*
kou	* !		
knou		* !	

By the hard domination of MAX over *COMPLEX of (14a), we can find that only [knou] was permitted in ME. Then, the variant [nou] began to

appear and we can represent this variation through the unranking (softening) process. But, because [knou] was still prevalently used, we display the difference of frequency between variants by soft domination of MAX(Less-Sal-C) over *COMPLEX as in (14b). At the later intermediate stage, [nou] became more and more frequently used than [knou]. This can be confirmed through the reranking of MAX(Less-Sal-C) with *COMPLEX and soft domination of *COMPLEX over MAX(Less-Sal-C) in (14c). In ModE, [knou] was finally simplified to [nou] and we can ascertain this simplification by the ranking (hardening) process or hard domination of *COMPLEX over MAX(Less-Sal-C) as in (14d).

Through the whole representation of historical sound change in (14), I have shown that the constraint reranking from (14b) to (14c) occurs when a 'soft' domination situation results from the change of (14a) to (14b). A direct reranking case, such as the change from (14a) to (14d) or from (14b) to (14d), does not display a gradual aspect of sound change in a proper way. It cannot explain the process of historical sound change, rather it only shows the result of the sound change.

3.3. Advantages over the Previous Approaches

In section 3.2, I have presented a new optimality-theoretic analysis of historical sound change focusing on the gradual aspect of change. Then, what are the advantages of my proposal over the previous approaches?

First, my approach can show the gradual aspect of sound change more naturally than Cho (1998) and Green (2001). To explain the variation at the intermediate stage, Cho and Green introduce unranking system and free ranking system, respectively. However, Cho (1998) and Green (2001) both do not show the gradient difference in frequency that occurred during the whole process of sound change. According to Cho's unranking system, both variants ([knou] and [nou]) occur equally side by side. As Green points out, this is intuitively unlikely. On the other hand, Green suggests free ranking system to explain sociolinguistic differences in the variation. But, even in the free ranking system, it just shows one form between variants determined by the sociolinguistic factors. It does not reflect the gradient shift of frequency in the variants properly. Contrary to two previous approaches, my approach reflects the scenario of sound change in a natural way.

The second advantage of my approach is that it can incorporate both

approaches. By separating the procedure of sound change into four stages, we can include the free-variationist model (Cho, 1998) and the free ranking model (Green, 2001). I present the relevant stages of all three models below.



- (15) Diachronic Reranking Hypothesis model
- a. ME : MAX(Less-Sal C) \gg *COMPLEX
↓
 - b. Intermediate 1: MAX(Less-Sal C) $>$ *COMPLEX
↓
 - c. Intermediate 2: *COMPLEX $>$ MAX(Less-Sal C)
↓
 - d. ModE : *COMPLEX \gg MAX(Less-SalC)
- (16) Free-variationist model (Cho 1998)
- a. ME (no variation) : MAX \gg *COMPLEX
↓
 - b. Intermediate (free variation): MAX, *COMPLEX
↓
 - c. ModE (no variation): *COMPLEX \gg MAX
- (17) Free ranking model (Green 2001)
- a. Middle English: MAX \gg *_o[kn]
↓
 - b. Intermediate stage
 - Grammar A: MAX \gg *_o[kn]
 - Grammar B: *_o[kn] \gg MAX
 ↓
 - c. Modern English: *_o[kn] \gg MAX

Though (15) does not cover all the relevant issues, it can be said that my approach contains the substantive arguments of each model.

Third, based on the scenario of sound change, my approach significantly enriches the OT formalism. On the basic convention of OT, I divided the dotted line into two types and interpreted the vertical dotted line in a novel way, involving the meaning of the soft dominance. In addition, I argued that in case of the sound change, constraint reranking should be applied across the vertical dotted line, rather than the solid



line. With the example of (14b) and (14c), repeated in (18) and (19), we again confirm this new interpretation of the vertical dotted line and the enrichment of OT formalism.

(18) Intermediate Stage 1

/knou/	MAX(More-Sal-C)	MAX(Less-Sal-C)	*COMPLEX
 nou		*	
kou	* !		
 knou			*

↓ (reranking)

(19) Intermediate Stage 2

/knou/	MAX(More-Sal-C)	*COMPLEX	MAX(Less-Sal-C)
 nou			*
kou	* !		
 knou		*	

In the above (18) and (19), we can see that the two variants [knou] and [nou] occur side by side. However, the implications of (18) and (19) are different from each other. (18) is interpreted in the way that [knou] occurs more frequently because MAX (Less-Sal C) is left-positioned in the soft domination and plays a more active role in the grammar. On the other hand, (19) is interpreted in such a way that [nou] occurs more frequently due to the deciding role of the left-positioned *COMPLEX constraint.

4. Conclusion

I have shown in this paper that we can represent historical sound change with the help of new interpretations of dotted lines in OT. In OT, language change is generally accounted for by employing constraint reranking. However, I argued that historical sound change must be represented as a series of unranking (softening), reranking, and ranking (hardening) stages in order to show the natural historical development of sound change. For this, I divided the dotted line into two types and reinterpreted the notion of the vertical dotted line. I also showed that the constraint reranking should be applied not across the solid line but across

the dotted line in the domain of sound change. With the example of consonant cluster simplification from Middle English to Modern English, especially [knou] to [nou], I have justified the proposal made in this paper.

However, I treated only the historical sound change based on the scenario of sound change. Further study on alliteration may provide some empirical evidence of the sound change scenario. Besides, though both synchronic variation and diachronic change are based on the same phonological principles (Kiparsky 1995) and every historical change must, at some point, have been a synchronic change (Green 2001), I wonder why we should treat the synchronic variation and the diachronic sound change in the same way.⁷⁾ To the extent that both types of variation are solved by the reranking of the constraints, we can say that both phenomena are similar. But, because the domain applied by constraint reranking is obviously distinct and the synchronic variation does not contain the flow of time, we cannot simply say that the synchronic variation and the diachronic sound change should be treated in the same way. Further empirical and formal investigation will be needed to sharpen and settle this issue.

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7) For more discussion on synchronic variation, see Anttila (1995) and Anttila and Cho (1998),

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